Past and future changes in salt marshes of Cape Cod National Seashore

Background

Vegetation patterns in salt marshes are largely based on elevation in relation to tidal flooding. In New England, vegetation is distinctly zoned into species that occur in the high marsh (elevations above mean high tide) and those that reside in the low marsh (elevations below mean high tide). The extent and distribution of these species are responsive to changes in water level, particularly sea level rise. (Figure 1)

In a study conducted by scientists in the Natural Resource Management and Science Division, six salt marshes within Cape Cod National Seashore (CCNS) were analyzed using a GIS-based mapping approach that utilized aerial images from 1984 and 2013. The results indicate that there have been highly variable amounts of change among marshes. There have been substantial losses of high marsh vegetation (>190 acres in total), while low marsh vegetation has exhibited large gains in some marshes and relatively minor losses in others with a total net gain of >131 acres. (Figure 2)

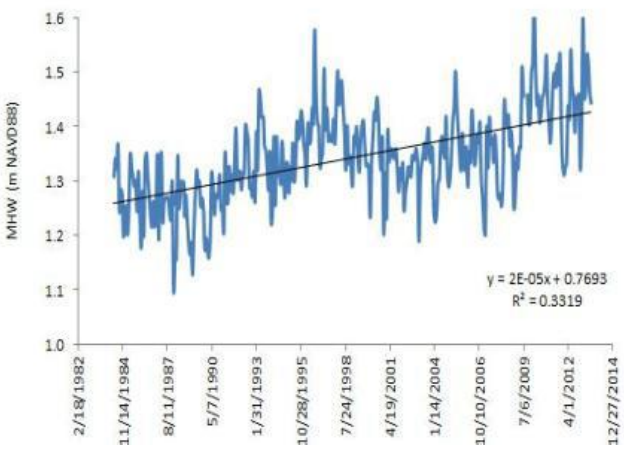

Figure 1. Mean high water level increase from 1984 to 2013 in Boston (NOAA).

Past Change

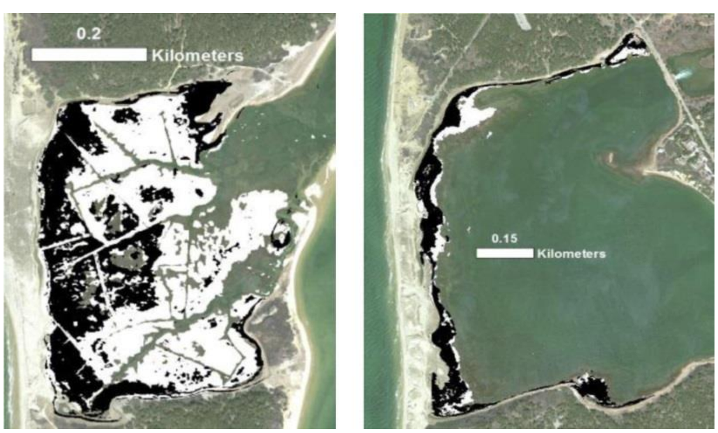

Figure 2. Area of high marsh in 1984 (white) vs. 2013 (black) in Middle Meadow and the Gut (Wellfleet).

Future Change

A comprehensive Real Time Kinematic Global Positioning System (RTK GPS) survey was conducted within five salt marshes at CCNS to create digital elevation models and *in situ* water level loggers were deployed to collect tidal data. From these data we calculated marsh surface elevations relative to mean high water elevations in 2013 and projected elevations with 50 cm and 100 cm of sea level rise by 2100 coupled with accretion rates that were based on parabolic plant productivity curves (Figure 3).

Vegetation responses were then modeled based on the relationship of high and low marsh zones with relative elevation. The results suggest that; 1) the majority of CCNS marshes sit low within their tidal frames; 2) high marsh will be most affected by sea level rise, with up to 100% losses under both the 50 cm and 100 cm SLR scenarios; 3) the vulnerability of marshes to sea level rise is variable depending on marsh elevation, sea level rise scenario (50 or 100 cm), and marsh zone (high or low marsh). While certain marshes are more vulnerable than others, substantial losses of both high and low marsh may occur within all marshes in response to sea level rise. (Figure 4)

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More Information

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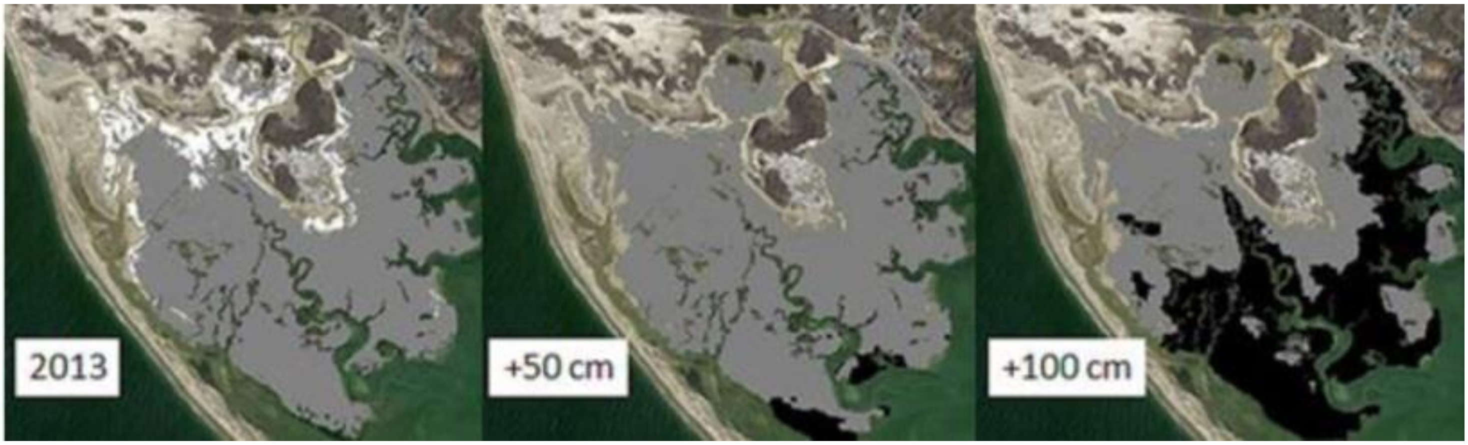

Figure 3. Predicted vegetation change in the West End Marsh (Provincetown) with 50 and 100 cm of sea level rise by 2100 (white=high marsh, gray=low marsh, black=no marsh).

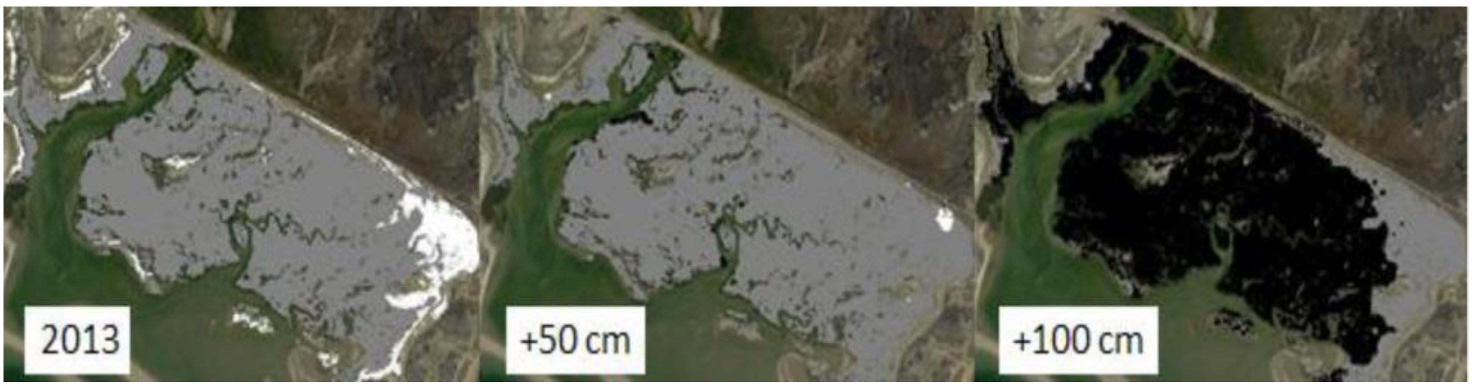

Figure 4. Predicted vegetation change in the Hatches Harbor Marsh (Provincetown) with 50 and 100 cm of sea level rise by 2100 (white=high marsh, gray=low marsh, black=no marsh).

These kinds of marsh vegetation changes have resulted, and will, result, in dramatic changes in ecosystem structure and function and ultimately the services they provide to humans in terms of flood control, erosion, water quality enhancement, and fisheries.